



Longitudinal Patient Record

A new concept for radiology reporting








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Solution

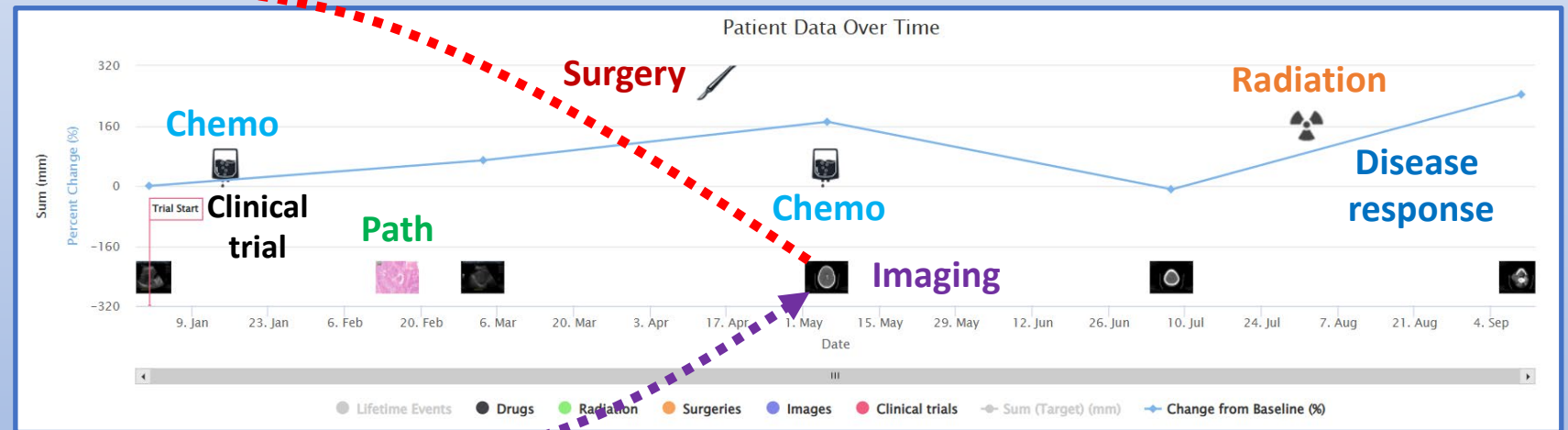
- A **longitudinal patient record (LPR)** integrates multidisciplinary data into a **comprehensive patient history**, but implementing an LPR is challenging due to the pervasive nature of unstructured content.

Interactive Multimedia Report

Key Images	ID	Side	Anatomy	Pathology	Priority	Metric
	Item 5		Liver	Steatosis	Important	
	Item 6		Liver, Segment 2	Metastasis	Important	18.3 x 23.3 mm
	Item 7		Liver, Segment 6	Metastasis	Important	20.6 x 22.5 mm
	Item 8		Spleen	Splenomegaly	Indeterminate	151 mm
	Item 10		Gallbladder	Normal	Insignificant	
	Item 11	Left	Kidney, lower pole	Cyst	Insignificant	12.2 x 15.7 mm
	Item 13		Portal vein	Normal	Insignificant	15.6 mm

Hyperlink back
to the source

Longitudinal patient record displays medical events over a lifetime.



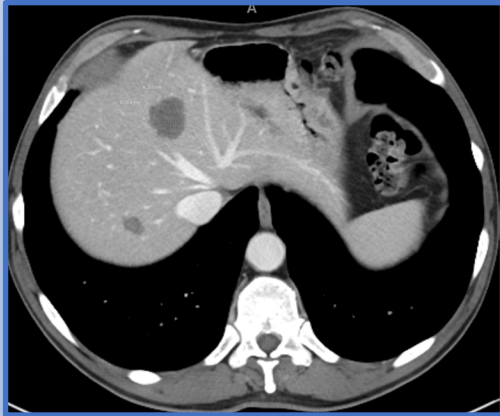
IMR data is used to create the LPR

- A solution is to use interactive multimedia reporting (IMR) with discrete data elements that can communicate a patient's health status via graphs, tables, and hyperlinked content.

Methods

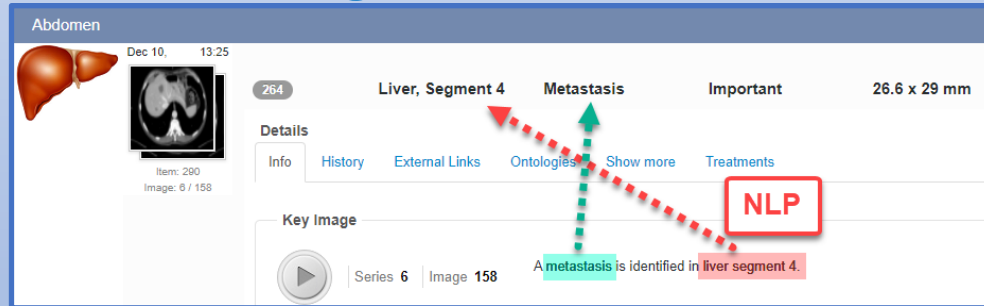
- A longitudinal patient record starts with the creation of structured data:
 1. Medical events (e.g., **radiology, pathology, treatments**) are recorded.
 2. Information is tagged with metadata describing the anatomical location of each event using natural language processing referenced to an ontology. The ontology accounts for synonyms/synoptic phrases to enable **uniform communication** when an event is described by variable terminology.
 3. The IMR is assembled with related information linked in timelines, and the IMR is then incorporated into an LPR. The IMR process is applicable to radiology, pathology, and treatment events.

1 - Record



A metastasis is identified in liver segment 4.

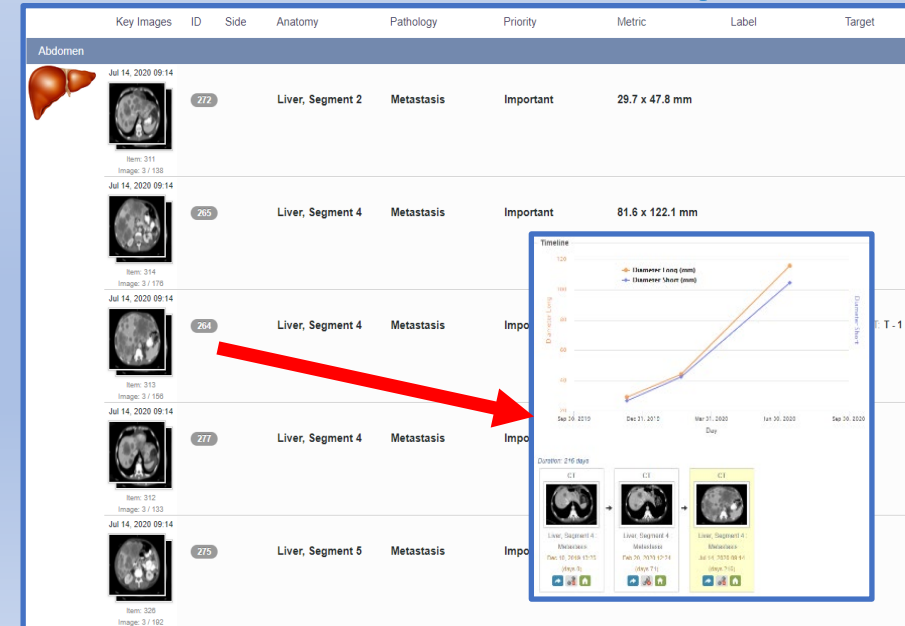
2 - Tag with metadata



Natural language processing labels events with metadata organized by an ontology.

**Anatomical Finding =
Timeline of connected events**

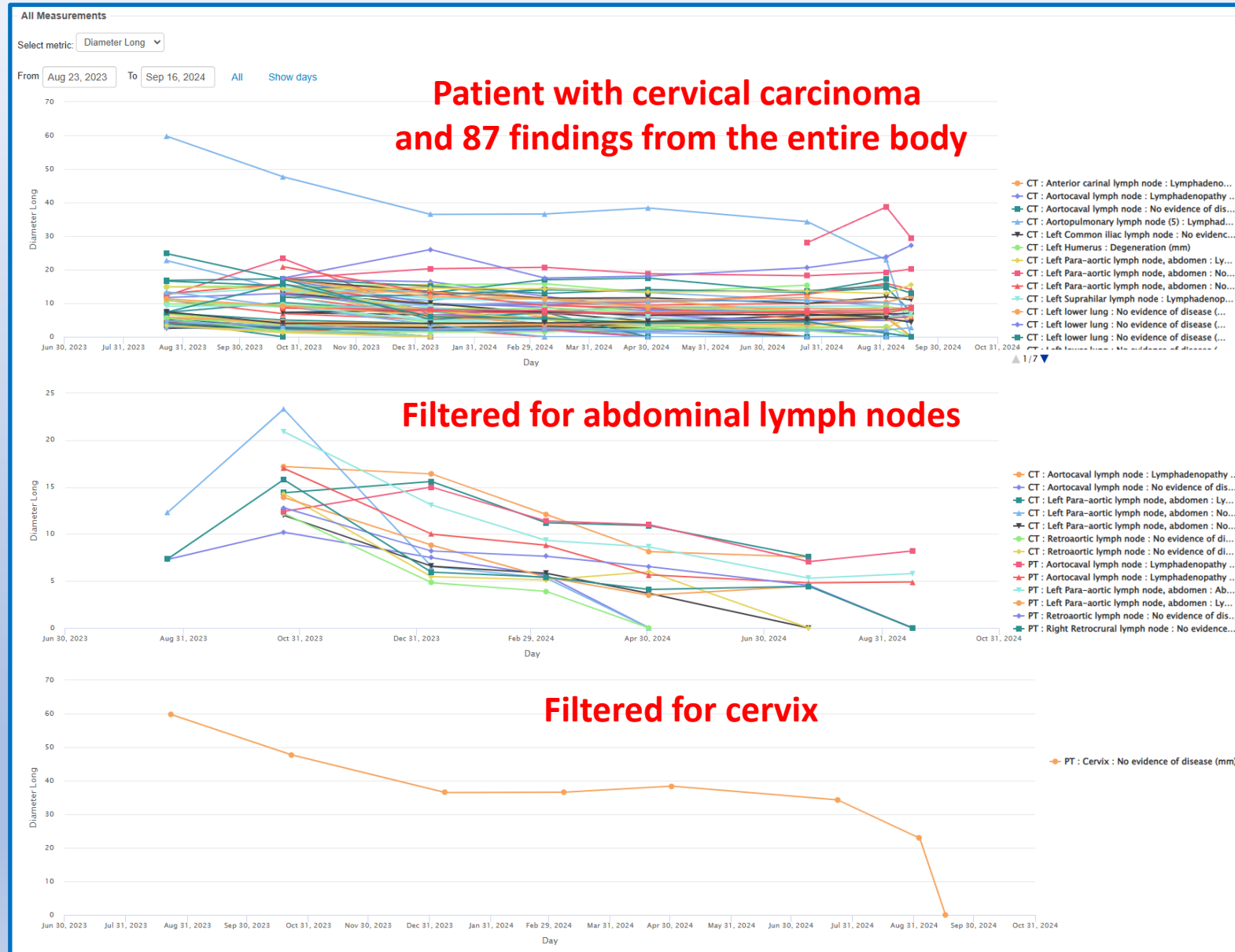
3 - Assemble IMR report



Key Images	ID	Side	Anatomy	Pathology	Priority	Metric	Label	Target
	272		Liver, Segment 2	Metastasis	Important	29.7 x 47.8 mm		
	265		Liver, Segment 4	Metastasis	Important	81.6 x 122.1 mm		
	264		Liver, Segment 4	Metastasis	Important			
	277		Liver, Segment 4	Metastasis	Important			
	275		Liver, Segment 5	Metastasis	Important			

Filter data for specific needs

- The LPR presents integrated multidisciplinary data over a patient's lifetime which supports **information continuity**.
- As a user creates IMR reports and links findings, the LPR highlights previous findings so that they are not overlooked.
- LPRs can be large depending on the number of integrated exams and findings, but it can be filtered to show specific anatomy, diseases, and/or time intervals.



Asynchronous data entry

- Findings can be added to an IMR report after its initial creation, and IMR reports can be added to the LPR from earlier dates as additional data becomes available to achieve **information continuity**.



Medical events (radiology, pathology, treatments) can be added to an LPR in retrospect as additional information becomes available.

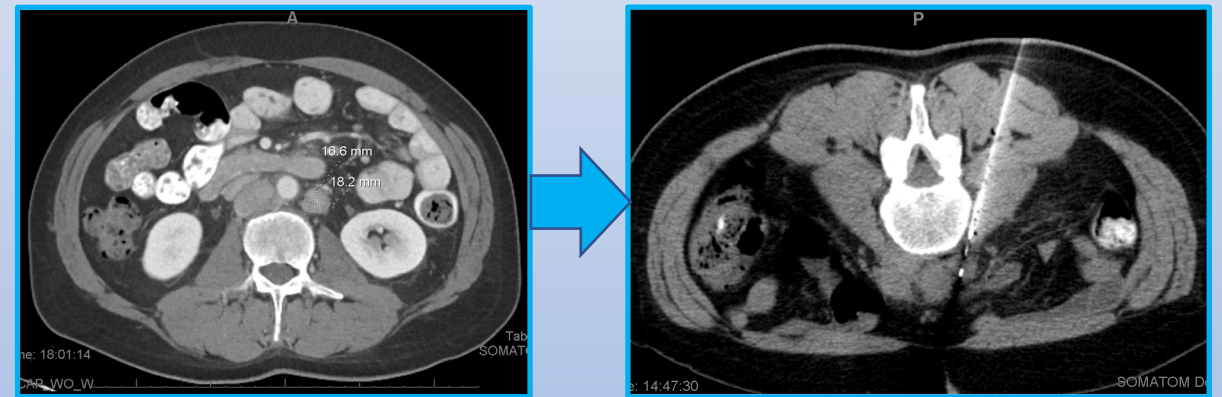
Compliance checks

- Compliance checks are automatically performed to warn a user when unrelated data is added to a finding timeline (e.g., when anatomy differs or when side/gender mismatch occurs).
- Furthermore, the **radiology-pathology-treatment correlation** can help to mitigate medical errors.

The user is alerted to anatomy mismatch during IMR report creation.

The image shows a horizontal timeline of four medical findings. The first three are CT scans of the right kidney, lower pole, dated Jan 1, Feb 2, and Mar 3, 2022. The fourth is a pathology report (SM) dated Mar 15, 2022, for the left kidney, lower pole, diagnosed as renal cell carcinoma. A red arrow points to the pathology report, indicating an anatomy mismatch.

Modality	Location	Date	Time	Days
CT	Right Kidney, lower pole : Mass	Jan 1, 2022	01:01	(days 0)
PT	Right Kidney, lower pole : Mass	Feb 2, 2022	02:02	(days 32)
CT	Right Kidney, lower pole : Mass	Mar 3, 2022	03:03	(days 61)
SM	Left Kidney, lower pole : Renal cell carcinoma, clear cell type	Mar 15, 2022	12:00	(days 73)



Connected data mitigates errors. For example, when a lymph node is biopsied, but path calls it kidney.

Pathology Report
Submitted Clinical History: Adenocarcinoma of sigmoid colon [C18.7] S23
Diagnosis: A: Kidney, left, site 1, retroperitoneal CT-guided biopsy: MODERATELY DIFFERENTIATED ADENOCARCINOMA INVOLVING FIBROADIPOSE TISSUE. (SEE COMMENT)

Identify patients with lung mets but NOT liver mets.

Data mining

- Structured data enables sophisticated data mining.
- Patient cohorts can be created from LPRs for the following:
 - Support clinical trials
 - Generate real-world evidence for regulatory decision-making
 - Determine medical outcomes

Search criteria

Finding

Lungs **Metastasis**

Inheritance Inheritance

▶ Modality:
▶ Aspect:
▶ Primary:
▶ Enhancement:
▶ Features:
▶ Status:

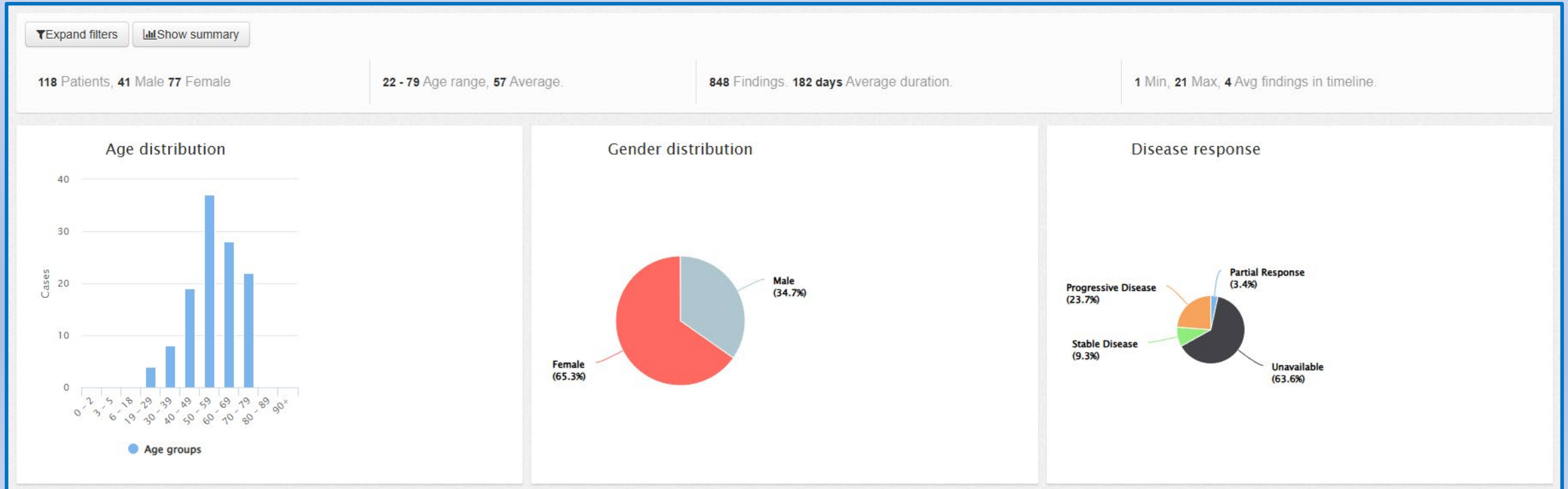
NOT

Finding

Liver **Metastasis**

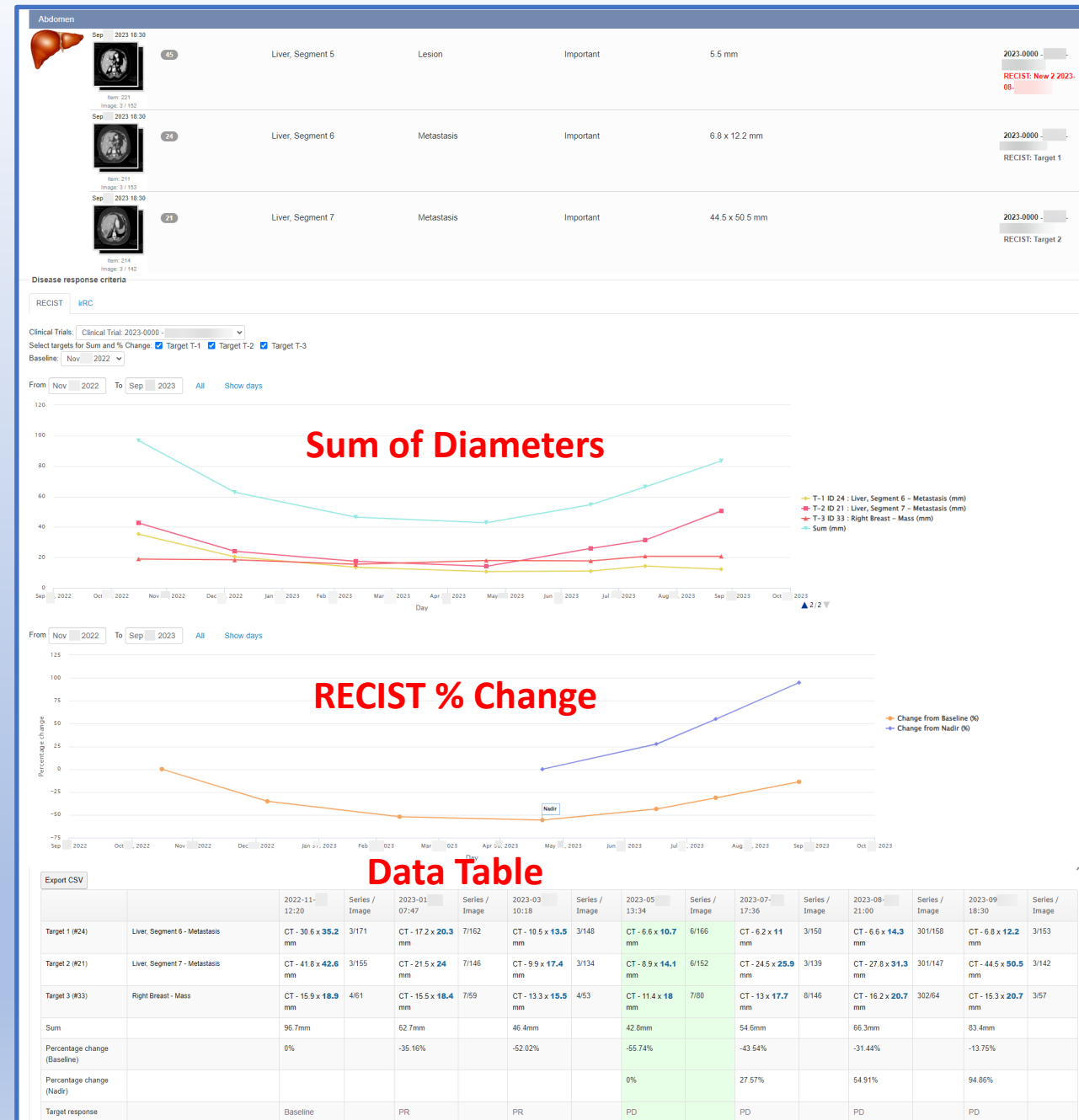
Inheritance Inheritance

▶ Modality:
▶ Aspect:
▶ Segment :
▶ Primary:
▶ Enhancement:
▶ Features:
▶ Status:



Results

- The system has been used to create:
 - 3,902 longitudinal patient records containing ...
 - 25,266 findings comprising ...
 - 77,833 events of connected information.
- The system currently supports 61 clinical trials evaluating the efficacy of cancer treatments.



Discussion

- A longitudinal patient record connects multidisciplinary data to efficiently communicate a patient's medical history and health status.
- Benefits include:
 1. Efficient access to information at the point of care
 2. Information continuity across exams and specialties
 3. Mitigation of medical record errors
 4. Drive towards complete disease analysis
 5. Determination of medical outcomes
- **An LPR represents an evolution in medical reporting.**



Longitudinal patient record connects information to better tell a patient's story.

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